computers and people

May—June, 1986
Vol. 35, Nos. 5-6

including *Computer Graphics and Art*

formerly *Computers and Automation*

KEEPING TRACK OF TASHKENT'S SUBWAY VIA COMPUTER-CONTROLLED MONITORS

The Computer Almanac and Computer Book of Lists — Instalment 47

Neil Macdonald, Assistant Editor

18 APHORISMS ON SOFTWARE CORRECTNESS (List 860501)

Software is computer programs and their data.

The software crisis is the widespread existence of unreliable software.

A software bug is an error or mistake made by a computer programmer, a computer designer, or a computer builder.

The National Aeronautics and Space Administration has recognized that it cannot develop error-free flight software.

You cannot fix a bug you do not know about.

Software bugs lurk unknown, waiting for unlikely but possible series of coincidences.

Most large computer programs are erroneous.

The phrase "software maintenance" is a frequent linguistic obfuscation of the software crisis.

A program can work properly a thousand times and fail suddenly the next time, because an unusual set of circumstances was encountered for the first time.

The phrase "software maintenance" is a software euphemism for "continued development".

It is impossible to expose all of the bugs in a program by continued testing.

The contents of black boxes have to be evaluated by externally observable characteristics.

Unfortunately, in evaluating black boxes in this way, you can never finish.

Black box testing is hopelessly inadequate for any thorough evaluation of computer program correctness.

Program testing can be used to show the presence of bugs, but never to show their absence.

- E.W. Dijkstra

If you double a program's capacity, it becomes much more than twice as hard to produce correct software.

Not all bugs are minor flaws - some of them can kill people.

It is not true that people could not foresee the bugs; what is true is that people did not foresee the bugs.

(Source: based on information in "The Sachertorte Algorithm" by John Shore, published 1985, 269 pp, by Viking-Penguin Inc., 40 West 23 St., New York, NY 10010; and slightly edited)

10 LOOK-ALIKES OR SOUND-ALIKES (CHALLENGES TO ARTIFICIAL INTELLIGENCE) (List 860502)

marital (in marriage) / marshal (official) / martial (warlike)

marry (wed) / merry (gay) / Mary (girl's name)

mascle (a steel plate) / muscle (an organ of the body) / mussel (shellfish)

maybe (perhaps) / may be (may happen)

maze (confusing paths) / maize (corn)

medal (award) / meddle (interfere) / mettle (spirit) / metal (material)

mews (cat's sound) / mews (stable) / muse (think)

mince (cut into small pieces) / mints (places where money is made) / mints (candies)

mind (brain) / mined (dug)

missed (failed) / mist (haze)

(Source: "The Bad Speller's Dictionary," published by Random House, Inc., New York, NY, 1967, 186 pp)

12 APHORISMS OR QUOTATIONS (List 860503)

Flattery is worse than an empty tin can in the belly.
- the Adjutant-Bird

Little jackals are very common, but such a crocodile as I am is not common.
- the Crocodile

With good luck, a keen eye, and the habit of considering whether a creek or a backwater has an outlet to it before you ascend, much may be done.
- the Crocodile

To be clean is one thing; to dust, sweep, and sprinkle seven times a day wearies the very gods themselves.
- the Adjutant-Bird

A liar only lies when he hopes to be believed.
- the Adjutant-Bird

If we listened to the howling of every jackal, the business of the town would soon stop.
- the Adjutant-Bird

He who trusts a liar will walk on duckweed in a pool.
- the Crocodile

Horse-food is better than the kick of a horse.
- the Jackal

Eat and be eaten was fair law along the river.
- Kipling

All the world forgets the Jackal and the Barber when the news has been told.
- the Jackal

How can a Jackal hunt with a Crocodile? Big thief and little thief: it is easy to say who gets the pickings.
- the Adjutant-Bird

(Source: from "The Undertakers" in "The Second Jungle Book" by Rudyard Kipling, Charles Scribner's Sons, 1899, 228 pp; slightly edited)

THE PERSONALITIES OF THE INTEGERS 76 TO 100 (List 860504)

76 2^2 x 19

77 7 x 11

78 2 x 3 x 13, triangular

79 prime

80 2^4 x 5, $4^2 + 8^2$

81 3^4, 9^2

82 2 x 41, $1^2 + 9^2$, $1^4 + 3^4$

83 prime

84 2^2 x 3 x 7

85 5 x 17, $2^2 + 9^2$, $6^2 + 7^2$

86 2 x 43

87 3 x 29

88 2^3 x 11

89 prime, $5^2 + 8^2$

90 2 x 3^2 x 5, $3^2 + 9^2$

91 7 x 13,
$1^2 + 2^2 + 3^2 + 4^2 + 5^2 + 6^2$,
$3^3 + 4^3$, triangular

92 2^2 x 23

93 3 x 31

94 2 x 47

95 5 x 19

96 2^5 x 3

97 prime, $4^2 + 9^2$, $2^4 + 3^4$

98 2 x 7^2, $7^2 + 7^2$, $1^4 + 2^4 + 3^4$

99 3^2 x 11

100 2^2 x 5^2, 10^2, $6^2 + 8^2$
$1^3 + 2^3 + 3^3 + 4^3$

(Source: Neil MacDonald's notes)

Ω

computers and people

formerly *Computers and Automation*

including *Computer Graphics and Art*

Vol. 35, Nos. 5-6
May-June, 1986

Editorial Offices
Berkeley Enterprises, Inc.
815 Washington St.
Newtonville, MA 02160
(617) 332-5453

Advertising Contact
The Publisher
Berkeley Enterprises, Inc.
815 Washington St.
Newtonville, MA 02160
(617) 332-5453

"Computers and People" (ISSN 0361-1442), formerly "Computers and Automation," is published every two months at 815 Washington St., Newtonville, MA 02160, U.S.A., by Berkeley Enterprises, Inc. Printed in U.S.A. Second-class postage paid at Boston, MA and additional mailing points.

Subscription rates, effective Sept. 1, 1984: U.S.A., $18.50 for one year, $36.00 for two years; elsewhere, add $8.00 per year.

NOTE: The above rates do not include our publication, the "Computer Directory and Buyers' Guide." To receive this, please add $20.00 per year to your subscription rate in the U.S.A., and $23.00 per year elsewhere.

NOTE: No organization in Switzerland or Morocco is authorized or permitted by us to solicit for, or receive payment for, "Computers and People" or the "Computer Directory end Buyers' Guide." All subscriptions to and payments for these publications should be sent directly to Berkeley Enterprises, Inc.

Please address all mail to: Berkeley Enterprises, Inc., 815 Washington St., Newtonville, MA 02160, U.S.A.

Postmaster: Please send all forms 3579 to Berkeley Enterprises, Inc., 815 Washington St., Newtonville, MA 02160, U.S.A.

Change of address: If your address changes, please send us both your new address and your old address (as it appears on the magazine address imprint), and allow four weeks for the change to be made.

Front Cover Picture

The front cover picture shows a woman operator checking the monitoring panel in the operations center for the Tashkent subway. At a glance, she can determine how close each train is running to schedule, and exactly where each train is along the route. A central computer system keeps track of the locations of all the trains, as well as sets the schedules and controls the operation of the trains. This subway system in Soviet Central Asia measures 25.5 km and services 350,000 passengers a day. For more information, see page 22.

Announcement

Starting May 6, *The Real World and Information Systems* will be published by Berkeley Enterprises, Inc., in newsletter style, six times a year (months: Jan., March, May, July, Sept., Nov.). This year copies will be free to all subscribers of *Computers and People* through Oct. 31, but thereafter the subscription rate will be $30 a year.

Key

[A]	—	Article
[C]	—	Monthly Column
[E]	—	Editorial
[EN]	—	Editorial Note
[O]	—	Opinion
[FC]	—	Front Cover
[N]	—	Newsletter
[R]	—	Reference

Notice

*D ON YOUR ADDRESS IMPRINT MEANS THAT YOUR SUBSCRIPTION INCLUDES THE COMPUTER DIRECTORY. *N MEANS THAT YOUR PRESENT SUBSCRIPTION DOES NOT INCLUDE THE COMPUTER DIRECTORY.

Editorial

The Loss of the Shuttle Challenger, and the Conflict Between Push and Wait

Edmund C. Berkeley, Editor

The tragic disaster of the space shuttle Challenger on January 28, 1986, and the sadness of seven worthwhile lives lost through mistakes and misjudgements may yet be a valuable lesson to the people and the administration of the United States.

Within the National Aeronautic and Space Administration (NASA) there were two strong drives in conflict. One drive was to push ahead with the program of activities and to be more and more intolerant of each successive obstacle and delay. The other drive was to wait a bit more to be certain, to continue to adhere to caution, the rules of safety first, the necessity for conservative judgement.

These are old forces upon human beings. I remember talking to a captain in the U.S. Navy who admitted to me that once he had been quite logically afraid of executing a most dangerous order but, of course, did so. As it happened, there were no bad results. Because later he mentioned his fear to higher officers, he was passed over next promotion time. The phrase "Full speed ahead and damn the torpedoes!" is very familiar. The sneer "so you are afraid!" is powerful ridicule.

But it is incontestable that "Discretion is the better part of valor." There is the old story of an Irishman who, it is reported, ran away from a battle, and when reproached later said with perfect logic "I'd rather be a coward for five minutes than a corpse for the rest of my life." No one can avoid the need for judgement in the conflict between PUSH and WAIT.

Far more serious than a space ship disaster is the towering problem of our time, nuclear war.

Everybody in the United States and in the rest of the world is faced with the possibility of the nuclear holocaust and the nuclear winter. The Soviet Union has committed itself to "no first strike." The United States so far has not committed itself to "no first strike." The Soviet Union tested no nuclear weapons from August 1985 to March 1986, as an "invitational" moratorium on testing. The United States continued to test nuclear weapons month after month without attention to the Soviet moratorium. The Soviet Union has not embarked on a "Star Wars" scheme. The United States has let over 1500 contracts for portions of the "Star Wars" scheme.

The mentality "Full speed ahead and damn the torpedoes" persists in the administration of the United States government.

It is clear that the eventual outcome of the arms race will be the almost complete extinction of the human race on the earth. All that anybody has to do is run the risk of a hazard year after year, decade after decade, century after century, and the hazard will surely happen.

What are we to do? Push ahead with the program of activities of the Pentagon (which used to be called correctly the Department of War) and the interlocking defense contractors and labor unions (who used to be known correctly as the Merchants of Death)? Or shall we use caution and judgement and apply the rules and probabilities of safety first?

This time the stake is not a billion dollar space shuttle and seven wonderful persons. This time the stake is a whole world, a planet where we fit nicely without space suits. A planet that is blue and green and tan and white when looked at from 20,000 miles above its surface. A planet where more than a million billion living things live.

High technology such as the space shuttle, electronic communication, silicon chips, supercomputers, worldwide television, and all these new wonders are not nearly as important as the simple technology of conflict resolution, user friendliness, satisfied customers, safety first, caution, tolerance, and honor.

Is it right to undertake building a system so complex that it cannot be proved that it will actually work correctly the first and only time it will ever be used -- like Star Wars?

Ω

The Information Industries: How Are They Changing?

Frederic G. Withington, Vice Pres.
Arthur D. Little, Inc.
25 Acorn Park
Cambridge, MA 02140

"Anyone trying to build a machine to outdo an animal at something that animals do well had better have plenty of perseverance."

An article I wrote in 1978 was entitled "Transformation of the Information Industries." In it I forecast that manufacturers of "information appliances," communications carriers and the publishing and broadcast media would converge and form new kinds of organizations.

Eight years is probably long enough to test the predictions. Accordingly, this article reviews the forecasts made then in the light of what has actually happened, and draws some conclusions about what we can expect.

Economy of Manufacturing Scale

The article reviewed the effects of changing technology. Observing that components were growing in size and complexity to the level of standardized subsystems, it said:

> "Economy of manufacturing scale has almost disappeared as a force in the information industries: it matters little whether a system manufacturer builds or buys its components, or needs few or many."

The article related this technical change to a financial change that was also occurring:

> "Users are now willing to make longer-term commitments and either purchase the equipment or enter into long-term leases with third parties. As a result, small manufacturers can grow more rapidly."

It then went on to draw what seemed to be a logical conclusion:

> "With small firms able to manufacture hardware and software competitively in the form of microcoded modules and free of lease financing pressures, IBM and the other giants may lose market share."

The Great Power of the Setter of Standards

This did not happen. IBM's share of industry revenue is about as high as it was then. I underestimated the power of the standard-setter, I think: he who sets the software and interconnect standards plays the tune to which his competitors must dance. Even though smaller companies are better able to compete financially, they have proved unable to attract many customers to non-standard products so they remain vulnerable to the giants' changes.

Artificial Intelligence

Artificial intelligence was already an interesting topic in 1978. The article said:

> "Simulation of human behavior will continue to be difficult. Humans excel at pattern recognition (a familiar face, a significant pattern of data) without knowing how they do it. Efforts to program computers to do the same thing have had very limited success, even though large amounts of research have been performed over many years. Partially effective products may prove to have large markets, and breakthroughs may occur. However, the rate of progress to date indicates that the pace of improvement will be slow."

If anything, I was too optimistic. Little in the way of AI-based products in routine use has appeared; the growth of machines for processing LISP and PROLOG has mostly been for experimental purposes. This growth may continue since symbolic modelling is proving useful as an approach to many kinds of problems unrelated to AI, but it doesn't change the conclusion:

Anyone trying to build a machine to outdo an animal at something animals do well had better have plenty of perseverance.

Satellite Communications

The article concentrated on changing communications technology. Speaking of direct-broadcast satellite communications, it said:

> "A few private users and numerous communities use satellite communications now. In the early 1980s medium-size businesses should be served economically, and in the 1990s small businesses and, conceivably, homes."

This was much too conservative: in 1986 many homes already have satellite receivers. However, no new industry structures have resulted because home satellite receivers are used only as alternate means of receiving broadcast TV. I failed to realize that the only significant home information system market existing today is for entertainment.

The Role of the Media

The article's enthusiasm for home information systems led to a forecast that the media (publishers, TV networks, producers of news and entertainment) would play a major role in the information industries. It said, enthusiastically:

> "In the future, evolved mass media are likely to be the primary agents of information collection, packaging, and distribution."

In fact, their role has changed little since 1978. There are more business training services; there is experimentation with new media like CDROMs (compact disk read-only memory); there are finally some successful home banking services; cable-oriented specialized TV channels are somewhat successful. There has been change and more will be coming. Maybe the article will prove right in the end, but not until decades have passed rather than years.

Text and Image Traffic

The potential for connecting information appliances into networks was already apparent. The article said:

> "As suitable communications services become available, many organizations will link word processors together to form internal electronic mail networks (thereby impacting the U.S. Postal Service, which may introduce a comparable service of its own). With these networks will come digital text filing and retrieval systems, and common-user information retrieval services will grow."

Waxing enthusiastic, the article then forecast:

> "Within a decade, digitized text and image communications volume will probably far exceed data volume, attracting the attention of information appliance manufacturers and communications carriers."

In fact, text and image traffic is still relatively small. Maybe another ten years will see the prediction come true.

The Communications Industry

In 1978 there was much talk of breaking up the Bell system and deregulating the communications industry. The article said, flatly:

> "Regulation of communications carriers must continue."

Two reasons were given:

> Surface communications systems are natural monopolies. It makes no sense to have multiple networks and switching centers when one will do.
>
> Broadcast communications must use the radio frequency spectrum, which is already jammed. Some unbiased agency must discipline its use.

Despite all the talk about free competition and deregulation, regulation of the communications industry continues and always will. The form may change, but even that will apparently occur at the glacial speed of the Federal Courts.

Computer Stores and Computer Retailing

In 1978 computer stores had begun to proliferate to distribute personal computers. It had also been evident for years that the branch sales office structures of most of the large computer manufacturers were clumsy at servicing small businesses. Accordingly, the article forecast that:

> "Sophisticated information appliance retailers will proliferate and evolve to match their product and market opportunities. The giant full-line companies will

adapt their distribution and service structures accordingly."

So far so good, but the article went on to forecast that IBM would participate directly.

"IBM is already close to being in the retail business, and nothing prevents it from selling consumer information appliances (e.g., digital TV sets) as well as business ones."

IBM tried and failed. Its product centers have now largely given way to arms-length sales of all lower-priced IBM products through third parties. Half right, then.

The International Structure

Finally, the article concerned itself with the international structure of the information industries. It said:

"A new international structure in the information industries is emerging. International mergers are occurring with increasing frequency. In the late 1960s American companies were acquiring foreign ones. The pattern has recently reversed: in the last two years more than a dozen American firms in the information industry were acquired by larger European and Canadian ones. Few acquisitions of American firms by Japanese ones have yet occurred, but they seem inevitable since the forces that have influenced the European acquirers are even stronger in Japan."

Since then, there have been some acquisitions of American firms by Japanese ones, but they have been few and cautious. Japanese firms have preferred to establish wholly-owned subsidiaries in America and build slowly, or else they work through partnerships with domestic firms. The article did not foresee the complex structure of mutually-dependent partners that has evolved among American firms, suppliers in the Pacific rim countries, and Europeans. A new international structure of the information industries is indeed emerging, but more slowly, cautiously and fluidly than the article anticipated.

Decrease of Government Interference

There seemed in 1978 to be an increasing amount of government interference with the information industries. In defense of domestic high-tech industry many governments were erecting import barriers and regulating standards protectively. Others were investing in struggling local companies, taking them over, and (to protect them) forbidding foreign ownership of local subsidiaries. The article concluded:

"During the next two decades the climate for the traditional centrally owned multinational corporation will continue to worsen, while the climate for various kinds of cooperative partnerships will improve. National governments will increasingly be either silent or active members of such partnerships."

I am delighted to say that the opposite has happened. Despite continuing political polemics, import barriers are generally lower than they were then. Government ownership has lessened; the trend has been toward "privatization". And almost all countries that forbade foreign ownership of local subsidiaries have new reversed themselves. Apparently the information industries are ones where government control simply does not work. The more nimble private companies have moved too fast for the bureaucrats to keep up. Even the governments of Japan, Taiwan and Korea, having succeeded in nurturing local exporters, are now being asked by them to get out of the way.

With Uncertainty Comes Opportunity

Several lessons can be learned from this retrospective:

1. Computers are different from people. Since computers have no consciousness or volition, they cannot generate a purpose that corresponds to a user's -- or any purpose at all. Intelligence can (at least apparently) be programmed into computers, but it will always be fundamentally different from animal intelligence. Animals have consciousness, self-awareness, and self-generated purposes: computers do not. Therefore, an industry based on artificial intelligence must grow very slowly at best, as we discover what it can really do.

2. People don't change very fast. People associate home information systems with entertainment, period. While interactive home information and banking systems have a precarious viability some places, that's all it is. We shouldn't blame the people; the producers are at fault for not developing material sufficiently attractive to be worth its cost. And businesspeople don't change very fast either. The article's forecasts of growth in electronic mail and multi-media nets would have been accurate if businesspeople had chosen to demand them.

(please turn to page 27)

Opinion

Science Fiction and Star Wars

Isaac Asimov
c/o Americans for Democratic Action
1411 K St. NW, Suite 850
Washington, DC 20005

"Modern nuclear war is world suicide."

Based on a report, January, 1986; Isaac Asimov is a scientist, a Ph.D., a former college professor, and one of the most famous authors of science fiction.

The Line Between Science and Science Fiction

There is a line between science and science fiction. I know. I have written on both sides of that line for forty-seven years. But I am terribly afraid that President Ronald Reagan does not know where that line is. And his confusion could cost us billions of dollars, or our lives, or both.

President Reagan is having a love affair with a fantastic scheme called *STAR WARS*. He would rather have us call it the Strategic Defense Initiative, but *STAR WARS* sums it up.

STAR WARS is a threat to:

- world peace,
- our national security, and
- the United States economy.

Like the Maginot Line (a zone of fortifications built in the 1930s across France to prevent another German invasion), *STAR WARS* is a dangerous delusion. Future historians will shake their heads over it -- assuming there will be future historians.

STAR WARS is advertised as a defensive system, but it would be dangerous to our national security. Even if it became partially operational, deploying it would violate the Anti-Ballistic Missile Treaty of 1972, and it would hurt the process of developing arms control. Arms control is the only real hope for our survival -- the survival of the world.

First, let me try to cut through some of the myth and fantasy surrounding this so-called "defense" system -- which is really not a defense system.

What is *Star Wars* supposed to do?

Here is how President Reagan thinks he understands it: *STAR WARS* would place thousands of devices in orbit around the earth to continually monitor surrounding space. As soon as an intercontinental ballistic missile with a nuclear warhead, or fifty such missiles, or five hundred, or more, are detected zooming their way from the Soviet Union to the United States, they would one and all be struck and destroyed in their tracks. The United States, totally unharmed, would then face a Soviet Union with its missiles uselessly expended. We would then be in a position to clobber the Soviets with our own missiles and wipe it off the face of the earth. Or, since the United States is good and noble, we would refrain, but would instead tell the Soviets firmly that unless they change their ways, we would clobber them. Naturally, the Soviets would then have no choice but to give in; so there would be universal peace; and so the world would bless Ronald Reagan.

But is that really possible?

I would be the last person to call something flatly impossible. But let us be realistic:

> Most people in a position to speak with experience and knowledge think that building *STAR WARS* will take at least fifty years.

Even if we should start today, we will have to survive far into the 21st century without

STAR WARS. And a great deal may change by then.

Ought we to put all our efforts, money, and emotional intensity into this long range project? And leave ourselves less ready to deal with far more immediate and more pressing problems?

How much will it cost?

No one can tell how much it will cost before *STAR WARS* is completed, but the guesses I hear run from five hundred billion to a thousand billion dollars. That's half a trillion to a trillion dollars!

Paying one trillion dollars for *STAR WARS* would require approximately all the individual federal income tax paid by all American citizens over a four year period. Borrowing a trillion dollars would increase the national debt by nearly 60 percent.

And from all our recent experience with weapons systems, it almost invariably takes far greater sums of money to complete the job than is anticipated. The corporate profit motive and Pentagon cooperation make sure of that.

But with enough time and money, would *Star Wars* work?

Let us be very imaginative and suppose that *STAR WARS* is put in place -- that it doesn't take too much time or cost too much money, and that it works perfectly. (I can imagine this because I am used to writing fiction!)

Well, there is a problem called "nuclear winter".

There is an increasingly strong opinion among scientists that even a "moderate" nuclear exchange will throw up a great deal of dust and ash into the stratosphere. In addition, firestorms from our burning forests and cities also will send vast quantities of ash and soot into the stratosphere. The net result will be that sunlight will be cut off, the Earth will go through a period of darkness and freezing temperatures, plant life will die, animals and human beings will starve. That is the nuclear winter.

As a matter of fact, even the Pentagon has now admitted that nuclear winter seems likely in case of nuclear war. Well then, how are we going to threaten the Soviet Union from behind our *STAR WARS* defense? Will we say, "We'll blast you into oblivion unless you surrender unconditionally right now?"

What if they answer, "Go ahead. You too will be destroyed."

It seems then that *STAR WARS* will not accomplish anything for us even if we have the time to build it, even if we can afford it, and even if it works as we think it ought to -- none of which is very likely.

STAR WARS is in fact only Hollywood science fiction, and like almost all Hollywood science fiction, it is bad science fiction.

What, then, ought to be done?

Modern nuclear war is world suicide. Once this is thoroughly understood, there will perhaps be a determined search for ways of limiting weapons of all kinds; and, best of all, for abolishing weapons of all kinds.

We need disarmament. We need international cooperation. We need a new world realization that we are all one species, Homo Sapiens, and that we must all stand together against the problems that face us all. That's what we need.

And we need to take action together... you and I and thousands of others.

Because if we can't achieve disarmament, cooperation and a feeling of world unity... then with leaders possessing the *STAR WARS* mentality, we are not going to survive much longer.

We have to explain to the American people why *STAR WARS* is such a dangerous delusion. We have to do so with material that is scientifically accurate and easily understood. We have to lobby the Congress. We have to begin right away. It is very difficult to end a weapons system once it is underway.

A few years from now, *STARWARS* won't mean just a fantastically impossible scheme for shooting down thousands of missiles -- it will mean jobs to thousands of people ... it will have political clout unrelated to its implications for national security.

We have to stop this science fiction dream, and restore science fiction to its proper place -- literature.

Ω

Robots for the Moon and Mars

Ronald D. Jones
Robotics Group
Phillips Petroleum Co.
1133 Garden Dr.
Bartlesville, OK 74003

"In deep space, where transportation costs are measured in thousands of dollars per pound, almost any viable outpost must at once begin struggling toward self-sufficiency."

Based on a report given at the International Personal Robots Conference 1985, c/o National Personal Robots Association, P.O. Box 1366, Dearborn, MI 48121.

For and Against Manned Space Flight

The case against manned space flight is irrefutable: human labor in space is incredibly expensive, not particularly efficient, and always a scarce commodity. Human beings bore easily, tire quickly, and die instantly when exposed directly to conditions existing anywhere beyond the environment which spawned them.

The case for manned space flight is equally irrefutable: astronauts can perform tasks beyond the capacity of any machine. The gift of our species is a mind brimming with curiosity, intelligence, and the ability to cope with the unexpected. Nowhere are these talents more useful than in outer space, or less prevalent than in the soul of a machine. The exploration of space has developed into a joint endeavor: machines whose capabilities expand almost daily, assisting and supporting humans whose ambitions grow likewise.

Almost without public notice, forces are in motion which may lead to a return to the moon, and the exploration of Mars, within the next 15-20 years. We are in the process of creating the technologies and the infrastructure necessary to support a human presence anywhere within the earth/moon system, or beyond. It seems inevitable the day must dawn when astronauts again land upon the shores of new worlds, this time to conduct systematic, thorough investigations.

The Moon and Mars

The moon and Mars are not islands; they are vast, complex bodies rich in geological diversity and mystery. Few secrets will be yielded to the casual passerby. Detailed exploration is likely to require years of diligent effort, and the establishment of manned outposts -- places where scientists can work, rest, and prepare for repeated excursions into the fascinating world outside.

As we contemplate developing bases upon the moon and Mars it behooves us to utilize wisely perhaps the most scarce commodity in the universe: human labor in space. That means designing facilities which are not labor intensive either to erect or to maintain. In other words, living and working quarters extensively automated, and heavily supported by robots.

Robots are tools, the most flexible, sophisticated tools ever conceived by man. They magnify human productivity -- and human potential -- by freeing people from menial, repetitious -- yet crucially important -- tasks.

Freeing Astronauts for Non-Trivial Tasks

In a situation where the total human population of an entire planet may number no more than 15, and the environment is both scientifically fascinating, and life threateningly hostile, one has to question the wisdom of using astronauts to sweep floors, drive trucks, or shovel dirt if these tasks can be robotized. There is reason to believe they can, along with numerous other activities. Not to "replace" astronauts, but to free them for the awesome task of ferreting out the secrets of a new world.

Precisely how robots might do this depends upon the technologies available when serious mission planning commences, perhaps 10-15 years hence. Private industry, government,

and the military will by then have lavished billions of dollars upon artificial intelligence, robotics, microelectronics, autonomous vehicles, and computers. God only knows what will be available, or what can be done with it, given creative minds and a blank check. But one can imagine numerous potential applications for space robots, particularly if some of the breakthroughs predicted today materialize.

In deep space, where transportation costs are measured in thousands of dollars per pound, almost any viable outpost must immediately begin struggling toward self-sufficiency -- developing the ability to produce food, water, oxygen, cement, metals, rocket propellants, etc. from indigenous materials. Which is another way of saying someone -- or something -- is going to be saddled with a staggering amount of repetitious, menial, yet crucially important work.

Tough, Smart Robots for "Trivial" Tasks

Work is what robots do best. To be precise, it is the only thing they do. Scorning coffee breaks and sleep, robots will labor without air, without light and water, oblivious to freezing cold and deadly radiation. And they will do this for years, serving one exploration team after another. Managed by earth bound scientists, extraterrestrial robots might undertake vast projects aimed not only at exploring the solar system, but also at exploiting its resources for the material benefit of all mankind.

Extraterrestrial robots not only have to be tough, they have to be smart. Smart enough to solve many difficult problems on their own. But that applies to future industrial robots as well as their more exotic "off world" cousins.

So what might the future hold? There is reason to believe at least five broad categories of extraterrestrial robots may evolve: 1) laboratory, 2) teleoperated, 3) autonomous, 4) specialized, and 5) "bootstrap."

Laboratory Robots

Laboratory robots are with us today, and their descendants are almost certain to play a role in any extraterrestrial research facility. The reason is simply a matter of logistics. We cannot possibly return to earth the truckloads of interesting soil, rock, and ice samples Martian and lunar explorers will find. Analyzing the material locally, and relaying the data to earth for detailed study, would appear to be the only practical solution. Unfortunately the preparation of geological samples for most types of analytical testing is both slow and labor intensive. Even on earth it is an expensive proposition.

That is why present day laboratories are beginning to robotize sample preparation procedures. Relatively inexpensive robots (costing as little as $40,000), armed with the appropriate workstations, are demonstrating the ability to grind, fuse, acid digest, weigh, dilute, and re-dilute (if necessary) a wide variety of samples, as well as to support automated analytical instrumentation by loading and unloading sample trays.

In an extraterrestrial setting, one can imagine their descendants relentlessly processing geological specimens selected by astronaut/geologists working in the field. An astronaut/chemist might "manage" the laboratory, but scientists on earth could plan and control most of its operations. Coupled with an automated sample storage and retrieval system, the laboratory might continue operating long after the astronauts depart for earth.

Cost "Guesstimates"

As for cost effectiveness, let us make a few "guesstimates": Assume a $40,000 robot can be rebuilt to government specifications for $1,000,000. The weight remains unchanged -- about 250 pounds for the robot and its support equipment. Assume transportation costs to Mars are $100,000 per pound. $1,000,000 plus $25,000,000 in transportation charges equals $26,000,000 for the delivery of a small laboratory robot to Mars. Can it pay for itself?

$20,000,000,000 is the price commonly quoted for placing 15 astronauts on the surface of Mars for a total of 460 working days. If the crew labors 12 hours per day seven days a week, that translates into labor costs of $4,025 per man minute (assuming the entire mission cost is charged to the man hours worked on the planet's surface).

At $4,025 per minute, the laboratory robot will pay for itself in 107.65 hours -- about four and a half days of continuous operation. After which it should continue to function for years, essentially for free.

For years the nuclear industry has used teleoperated (remote controlled) robots to handle hazardous materials from a distance

-- i.e. safely. Similar machines might find a niche performing dangerous tasks off world, but it is more likely they will find much wider application serving as surrogate arms for astronauts working in a shirt-sleeve, radiation shielded environment.

Spacesuited astronauts laboring under gravity's burden are only minimally efficient. Walking and bending require considerable effort. Hands sealed inside pressurized gloves lose much of their agility and tactile sensitivity. The astronaut's field of vision narrows, and a space suit offers scant protection against cosmic rays, or energetic particles vomited into space by solar flares.

Establishing an Extraterrestrial Outpost

Establishing an extraterrestrial outpost will require a considerable amount of manual labor, labor that is brutally tiresome, and potentially hazardous if performed solely by humans trundling about in rigid suits. Tireless, superstrong, teleoperated robots might assume many of these tasks, allowing human operators to effortlessly manipulate objects weighing tons even in a low gravity environment.

Astronauts are already using the shuttle's remote manipulator system (RMS), or robot arm, in a similar fashion. An advanced version will be incorporated into the space station.

The Autonomous Land Vehicle

On a wider scale, remotely directed mobile vehicles could scout scientifically interesting but potentially hazardous geological sites. They could climb crumbling canyon walls, for example, or probe areas of volcanic activity.

Like their laboratory cousins, teleoperated robots require only modest advances in present day technologies to prepare them for roles on new worlds. This is not true of autonomous vehicles.

An "autonomous vehicle" is a mobile robot possessing a high degree of what might best be described as "common sense." It would be capable of both recognizing and solving numerous secondary problems not specified in the primary assignment.

For example, given the instruction "go to Base Camp X," an autonomous vehicle might, on its own initiative: (1) determine its present location; (2) determine the location of Base Camp X; (3) plot a route that considered the nature of the terrain to be traversed; and then (4) drive itself, at a respectable speed, to Base Camp X, intelligently negotiating unexpected obstacles -- like canyons and boulders -- while holding to its intended course. This is very far beyond present day technology.

Today's mobile robots are slow, clumsy, stupid, and practically blind, but no scientific law decrees they must remain so. Numerous projects are under way with the stated goal of breathing reality into perhaps the most exciting concept in robotics.

Specialized Robots

One of the most intriguing, and probably the best financed, is the Defense Advanced Research Project Agency (DARPA)/Martin Marietta Autonomous Land Vehicle (ALV) program. The goal is to create by 1990, in a series of increasingly ambitious steps, a tank-like vehicle capable of planning its own route through rugged, unmarked terrain at speeds of 6 to 30 miles per hour.

On another world autonomous vehicles might assume a modular form, the "core" module being a computer controlled tractor capable of "plugging" itself into an assortment of "applications" modules (truck beds, earth moving equipment, manipulators, etc.). One can imagine autonomous vehicles ferrying supplies to distant exploration camps, "strip mining" ore, and clearing roadways. (Roadways are important -- routinely traversing boulder strewn landscape leads to repairing broken axles, righting overturned vehicles, and moving at glacial rates of speed). On Mars a valuable cargo might be ice, robotically scooped up at one of the poles and transported hundreds of miles back to base, the robot relying upon directional fixes from satellites to guide it across the desolate, dust-storm ravaged landscape.

But can robots survive in such a dirty, harsh environment? A mobile robot would likely consist of two basic components: a computer, which would be small and easily protected, and a tractor (or truck or bulldozer) controlled by that computer. The question really is: can we devise a mobile vehicle, with wheels and gears and drive shaft and motor, that will function reliably in a dusty near vacuum? If the answer is no, then it's not just goodbye mobile robots, it's goodbye extraterrestrial exploration as well. Whether that tractor-like module is driven by a computer (and becomes a robot), or a human (and is called a truck/rover), it

will be exposed to the same dust, vacuum, and abuse. If the system cannot survive, the Mars explorers, and their lunar counterparts, will embark upon the exploration of those worlds armed only with picks, shovels, and walking boots.

Autonomous robots could venture into proposed outpost areas in advance of humans, exploring the terrain, leveling landing sites, inspecting -- even unpacking -- unmanned cargo vehicles arriving from earth. Following such a strategy, mission control would gain experience handling interplanetary flights, and be assured most of the equipment necessary for establishing and maintaining the base was safely in place before committing the landing expedition.

One last comment on the subject: autonomous robots need not be land mobile, at least not on Mars. The Martian atmosphere is sufficiently dense to support a properly designed blimp.

The Base's Greenhouse

"Specialized" robots is catch-all classification encompassing devices not readily lending themselves to any other category. They might be mobile or stationary. Their functions would be limited only by imagination, available technology, and funding.

A "housekeeping" robot, scurrying about with the technological equivalent of a feather duster, would likely appear on everyone's wish list. "Pet" robots, charming, witty companions, but not necessarily capable of doing any useful work, might find a niche. (However there is a good chance many of the outpost's robots will be, at least partially, voice actuated, and quite clever in their programming.)

More serious applications might include a robot that wanders around "sniffing" out air leaks. Or one that, following instructions radioed from earth, reassembles equipment shipped disassembled (for maximum utility of available cargo space within the transport vehicle's reentry shield). A voice actuated "hospital" robot could prove invaluable should one of the crew become ill, or incapacitated (break a leg, for example).

The base's greenhouse will probably be heavily automated, and robots may find a niche there as well, possibly planting and harvesting certain crops. (A robot has already been used to transplant pepper plants.)

Bootstrap Robots

But if extraterrestrial outposts are ever to evolve into permanent settlements, one additional type of machine seems almost mandatory: "bootstrap" robots.

These are miniature, totally automated systems designed to exploit indigenous materials, extracting from them oxygen, metals, glass, cement, water, and other items needed by the base to survive and grow. Similar robots would, in turn, convert these into sheet metal, solar cells, rocket propellants, bricks, etc. -- or, to use a slang phrase, the robots would "pull the base up by its bootstraps." All with minimal human involvement.

More like miniature factories than robots, bootstrap machines are both simple in concept and enormously seductive in appeal. They also represent one of the most formidable engineering challenges ever handed modern science: developing a family of mining/metallurgical/manufacturing machines epitomizing compactness, reliability, and ruggedness, not to mention a miser's knack for hoarding and recycling supplies imported from earth. Of course the high tech revolution seems to be pushing present day industry in the same general, totally automated direction. However, there is a point beyond which additional automation and robotization cannot be economically justified in earth-bound operations.

Not so in space. The bottle neck is transportation costs, running into the thousands of dollars per pound for material delivered to another world. Under these conditions a miniature factory weighing perhaps 50 tons, and capable of generating 500 tons of useful product annually for decades, could pay for itself many times over almost irrespective of the development cost. But the real payoff would be a drastic shortcut -- perhaps the only truly feasible route -- to both the exploration and the colonization of space.

Robots that Reproduce

Some theorists believe bootstrap robots may beget an even more sophisticated machine (or, more accurately, a hive of specialized robots and automated mechanisms, all acting under the control of a supercomputer endowed with artificial intelligence probably exceeding today's wildest predictions). It, too, would eat dirt and regurgitate useful products, but it could also manufacture exact copies of itself. In other words, it would

(please turn to page 27)

Wind Shear and Computers

James W. Wilson
National Center for Atmospheric Research
P.O. Box 3000
Boulder, CO 80307

"Wind shear is an inclusive term, defined as any sudden change in wind speed, wind direction, or both. 32 plane crashes and near-crashes since 1964 have been due to this phenomenon."

Based on an article *An Ill Wind* in *Natural History*, March, 1986 (Vol. 95, No. 3); published by and copyright by the American Museum of Natural History, Central Park West at 79th St., New York, NY 10024. Reprinted with permission.

On July 9, 1982, Pan Am flight 759 crashed during takeoff from New Orleans International Airport, killing 153 people. The National Transportation Safety Board determined that low-altitude "wind shear" was the probable cause. Three years later on August 2, 1985, Delta flight 191 crashed while landing in Dallas, Texas, killing 137. Headlines and newscasters again blamed wind shear. Even the blue ribbon panel assembled by the National Research Council after the New Orleans accident determined that thirty-two plane crashes and near crashes since 1964 were due to the phenomenon.

Wind Shear

Wind shear, however, is an inclusive term. Meteorologists define it as any sudden change in wind speed, wind direction, or both. Wind shears are created by air flowing over rough terrain, by warm air currents rising from sun-heated ground, by the collision of air masses of different temperatures and moisture content, and by thunderstorms. Most have no effect on airborne planes. Some, referred to as turbulence, are felt as bumpiness. But a few actually bring about crashes. Even a casual observer knows that the wind varies frequently in intensity and direction and wind shear is a common occurrence.

The Starburst Pattern

The type of wind shear that imperils aircraft during takeoffs and landings needed greater definition. To this end, field experiments were recently conducted in Illinois and Colorado by scientists from the University of Chicago and the National Center for Atmospheric Research (NCAR) in Boulder. These experiments established that a wind shear called a microburst is responsible for aircraft accidents. Microbursts are produced when a rain shower or thunderstorm creates a current of rapidly downward moving air -- a downdraft -- that spreads out horizontally in a starburst pattern when it strikes the ground, just as water from a faucet spreads out when it hits a sink.

Meteorologists have long been aware that thunderstorms produce downdrafts that spread out horizontally in oval patterns at ground level, causing cool and sometimes violent winds. As far back as 1671, an Oxford fellow, R. Bohun, wrote "A Discourse Concerning the Origin and Properties of Wind" in which he described and sketched wind flows from clouds that suggest some awareness of the winds in a microburst. In 1946 and 1947 two University of Chicago meteorologists, Horace Byers and Roscoe Braham, documented the downdrafts caused by thunderstorms and the resultant horizontal winds near the ground. Until recently, however, even specialists did not understand that these airflows occurred in varying sizes and strengths and those of some diameters were especially hazardous for aircraft.

Downbursts

In April 1974, Theodore Fujita, a meteorologist also at the University of Chicago, who was studying aerial surveys of tornado damage, observed that small starburst damage patterns were caused by high-speed, small-scale, short-lived downdrafts. He named these starburst airflow patterns downbursts. Following an investigation of the Eastern Airlines crash at Kennedy International Airport in New York City on June 24, 1975,

Fujita hypothesized that the crash probably took place when the airplane penetrated a downburst while landing. He later subdivided downbursts into several categories based on the size of their horizontal outflows. Downbursts having outflows with diameters of between 0.25 and 2.5 miles were called microbursts. This is the scale that we now know presents the greatest risk to aircraft.

Actual Observation of a Downburst

The first field program to study downbursts, called NIMROD (for Northern Illinois Meteorological Research on Downbursts), was conducted in Illinois in 1978 by investigators from the University of Chicago, the Illinois State Water Survey, and NCAR. Using Doppler weather radars that measure air motion within storms and a network of anemometers (instruments that measure wind speeds and direction), meteorologists were able for the first time to actually observe the airflow in a downburst. Before that, downbursts were largely hypothetical. Doppler radars measure the speed of targets moving toward or away from the radar antenna. They do this by measuring the frequency change between the transmitted microwave signal and the return signal after bouncing off a target. The frequency change is related to the speed of the target. This is the same principle employed by the police when they use Doppler radar to clock the speed of automobiles along a highway. In the case of weather radars, what is being clocked are raindrops, snowflakes, and even insects that are carried by the wind.

A second successful field experiment to investigate downbursts, called JAWS (for Joint Airport Weather Studies), was carried out in 1982 at Stapleton International Airport in Denver. This investigation was conducted jointly by Fujita, John McCarthy of NCAR, and me. We used three Doppler radar installations near the airport and recorded data on more than seventy microbursts. Analysis of our data indicated that the average microburst lasts only ten to twenty minutes, that the typical wind shear immediately following the downdraft hitting the ground is twenty-seven miles per hour, and that wind shear increases to fifty-six miles per hour from five to ten minutes after the initial impact and then decreases rapidly. Because of the small size and short lifetime of a microburst, existing wind-measuring systems at airports are frequently unable to detect microburst winds in time to warn aircraft. Low-Level Wind Shear Alert Systems have been installed at about 110 major airports across the country and are the only systems now in use that provide wind shear warnings. (The Doppler weather radars already in place are used primarily for weather research rather than for issuing alerts. But beginning in 1988, the United States government plans to begin installing a national network of Doppler weather radars to improve weather warnings.)

The Danger to Planes

Wind shear endangers planes for the following reason. Once a plane enters a microburst, it encounters an increase in head winds radiating away from the center of the downdraft. This increase in head winds enhances the airflow over the plane's wings, causing the plane to pitch upward and forcing the pilot to compensate by reducing engine power. Then, as the plane passes through the downdraft center, the head wind rapidly decreases and becomes a tail wind, and the airflow over the wings suddenly falls off, with a concomitant decrease in lift. Any additional loss of airspeed caused by the pilot reducing engine power and/or the downdraft of air pushing the plane toward the ground contributes further to this hazardous situation. With loss of speed, airflow over the wings may be reduced to the point at which the aircraft stalls and sinks rapidly toward the ground. If the plane is too close to the ground when this happens, there may not be enough time for the pilot to react and for the engines to regain sufficient power to compensate for the loss in airspeed. This is the likely sequence of events that caused the Pan Am plane to crash during takeoff at New Orleans International Airport. The wind shear in that accident was estimated at about fifty miles per hour within a distance of 1.5 miles, indicating that wind speed need not be extreme to pose a serious threat to aircraft. These conditions pose the same problems during takeoffs and landings.

Research based on the JAWS data has shed light on the causes of a microburst. Before there can be a microburst wind shear a strong downdraft must reach the ground. This most commonly happens when a region of relatively cool air is generated, either within a cloud or below a cloud base. Such cool air masses are usually produced in two ways: the evaporation of rain or ice into dry air above ground level and the melting of ice as it falls to an altitude below the freezing level of the air. Because cold air is denser than warm air, it sinks toward the ground, producing the downdraft. Calculations based on

computer models and on actual measurements show that downdrafts produced under these conditions can easily reach forty miles per hour. When a rapidly moving downward air column hits the ground, it has the potential of turning into horizontal winds moving in opposite directions at speeds of about forty miles per hour, thereby creating a strong wind shear.

The Precipitating Cloud May Look Innocent

Because precipitation is important in the production of a downdraft, microbursts are always associated with a precipitating cloud. The rain need not actually reach the ground, however. In the dry climates of the western states, rain may evaporate completely before it reaches ground level yet still produce a strong microburst. These above ground-level showers are a particular threat to aircraft because the precipitating cloud looks innocent and the pilot may be caught completely unaware. This is what happened on May 31, 1984, when a United Airlines jet was taking off from Denver's Stapleton Airport. The plane was departing during a seemingly benign shower in which only a few raindrops reached the ground. But just as the plane was lifting off the runway it penetrated a microburst and lost about twenty-five miles per hour of airspeed. The plane was only about ten feet off the ground and eleven hundred feet beyond the end of the runway, when the fuselage was punctured in three places by an antenna on the ground. The plane then moved out of the microburst and rapidly gained altitude but had to return to the airport because the holes in the fuselage made it impossible to pressurize the cabin. An almost certain disaster was narrowly averted because the pilot used a recently developed microburst flying procedure that involved pitching the plane up while moving at a low speed. However, this new procedure does not mean that pilots can now safely fly through microbursts. If the tail wind had been only slightly stronger, a crash would have been unavoidable.

A Real-Time Warning Service

As a result of this incident, the Federal Aviation Administration asked NCAR to conduct a microburst "real-time" forecast and warning service (that is, a system in which information about a microburst would be given immediately to those who need it) at Stapleton Airport for the remainder of the 1984 microburst season. (Microbursts are seasonal. They are associated with thunderstorms or rain showers and occur during spring and summer, or whenever such storms take place in a given region of the United States.) This experiment, called CLAWS (for Classify, Locate, and Avoid Wind Shear), depended primarily on meteorologists trained to identify and locate wind shear events on Doppler radar screens. This information was immediately transferred by radio to another meteorologist in the Stapleton Airport traffic control tower who passed the information on to the flight controllers who, in turn, notified pilots. This labor-intensive but very successful test demonstrated that Doppler radar could provide timely wind shear warnings. During the experiment, one pilot who was approaching for a landing credited a microburst advisory with saving his "aircraft from being forced into the ground short of the runway." In practice, the advisories would be transmitted directly, instead of indirectly, to the pilots.

Improved Computer Models

The CLAWS project demonstrated that the technology exists to greatly reduce the risk of aviation accidents caused by wind shear. It also demonstrated that early advisories of wind shifts enable controllers to anticipate needed changes of runways, thereby decreasing delays and saving aircraft fuel. During the next five years a procedure is likely to evolve that will provide warnings of wind shears and other hazardous weather conditions to most major airports. This system will be based on new Doppler radars and will be capable of estimating wind speeds and direction every 200 to 300 feet within a fifty-mile radius. The primary task ahead is to develop improved computer models that will rapidly extract wind shear and weather information from radar and other instrument data and communicate it in a concise, informative manner to pilots as quickly as possible.

Ω

A Computerized Newspaper Route: Management By Remote Control

Grant Campbell
Campbell Communications
1940 Embarcadero
Oakland, CA 94606

"We want to keep every customer we can and we're as liberal as we can be with them."

Problem: Remote Control Management

Ron Thomas was confronted with a crisis in his family-run newspaper delivery business two years ago after his mother died. According to Thomas, "Mom had been keeping track of customer and payment records with a few sketchy notes and a lot of brain power. She kept some information on three-by-five index cards, but basically she was running the business in her head." After she died, the business experienced a severe cash flow crisis, Thomas said. "That made me realize I had to gain administrative and financial control of the situation or possibly lose my investment in the route," which he purchased nine years ago.

Thomas's mother and step-father had operated the route for about seven years. "I didn't want to become involved in the day-to-day management, because I live and work about an hour's drive from where the route is located. For me to run it, I'd have to give up my regular job and move, which wouldn't make any sense."

Thomas, 45, lives in Kansas City, Missouri, and works in the nearby suburb of Overland Park as a claim auditor in a major trucking company. The newspaper route, which grosses about $100,000 a year, is located in Richmond, Missouri, about 45 miles northeast of Kansas City.

Contract Services System

To enable him to oversee management of the business by "remote control," he decided to computerize its operation. "I didn't know anything about computers, but my younger sister, Sally, had been using a microcomputer to generate financial statements for the route. After discussing the additional capabilities that would be needed, we decided to install a Contract Services System."

The Contract Services System was designed to automatically generate bills and handle receivables accounting for small to medium-sized businesses that bill their customers a fixed sum for a specified period of time. The software package keeps track of the amount owed by customers for each due date, and automatically issues bills, postcard statements and reports. The system fully integrates with other packages, so relevant financial data need only be entered once to flow through all applicable programs and reports.

Thomas runs the Contract Services software on a single-user microcomputer with dual floppy disk drives and a CP/M operating system.

"We were the initial user of the Contract Services package," Thomas notes. The system was installed in mid-1983, he said. "I wanted it to manage my newspaper business without costing me much time, and the system has done that for me. If I had to do it manually, I'd be out of the business today because I can't be involved on a day-to-day basis."

The business, recently incorporated as Richmond Star Route, Inc., delivers two daily papers, the morning "Kansas City Times" and the afternoon "Kansas City Star", as well as the "Sunday Star" to about 760 customers. "Almost all my subscribers get both papers. I have very few who get split delivery," Thomas explains, "because for 50 cents more per month you can have them both."

Independent Newspaper Carrier

In the jargon of the newspaper industry, Thomas's firm is an independent contract car-

rier. The papers he carries are published by Capital Cities Communications. His company also owns five newspaper dispensing machines in Richmond. Additionally, the firm delivers about 450 papers on Sundays to three major grocery stores in that community. Furthermore, on Wednesdays the company delivers a special shopper edition of the "Star" to all non-subscribers of the regular dailies. "Every week we deliver about 2,000 extra papers in addition to the 700 plus receiving the regular paper," Thomas said. "The 'Star' pays us for that service. Advertisers are thus assured that every household will receive a mid-week paper."

The Contract Services System generates three key lists that streamline deliveries along the 50-mile-long route. "It gives a list of all customers by street, in address number sequence with the customer's name, account number, telephone number, and other information. Most importantly, it generates a route sequence list, which tells the delivery crews where to throw the papers. If there is a change -- for instance, if a customer is on vacation -- the computer will tell the crew not to deliver a paper to that number on the sequence list."

Subcontracting the Trucking

Thomas subcontracts pick-up, bundling, bagging and delivery of the papers. Usually the route is divided into territories for two separate trucks, but on days when the paper is very thin, one truck covers the entire route in about two hours.

The subcontractor that delivers the papers also handles phone calls from customers, Thomas said. "If a caller leaves an incomplete message to temporarily halt service at a certain address, we can query the computer lists to determine that customer's name and phone number. We then call back to confirm the order."

Failure to Bill and Lost Bills

Failure to bill, and lost bills, were major contributors to the low cash of early 1983 that prompted Thomas to computerize the route. "The bills had been thrown every month with the paper," he recalls. "Sometimes dogs would take the papers, sometimes no bill was inserted with the paper, and sometimes the paper just didn't get thrown. As a result, at times up to half the route didn't get billed."

Now, the Contract Services System automatically bills all Thomas's customers. The computer prints payment labels containing six monthly billing labels and six return address labels. Thomas sends these to each customer twice a year although the computer system allows him to send them out more often if he chooses.

The billing label shows the month and year for which payment shoud be remitted, the account number, and the customer's name and address. Customers who pay six months to a year in advance are sent computerized statements instead of payment labels.

For regular subscribers, Thomas charges $10 a month, which covers home delivery of the morning, afternoon and Sunday papers. Senior citizens and persons on limited fixed incomes are charged $9 a month; so are regular customers who pay six months to a year in advance. Customers who pay three months in advance are charged $9.33 per month. Only a few business customers take advantage of the prepayment discounts. Temporary customer-requested service interruptions of two weeks or more are automatically translated into billing credits by the system.

The billing and mailing labels are printed on a letter-quality printer with a tractor feed. "You simply put a sheet of continuous labels in and the computer prints them," Thomas said. "Now we only have to go through our billing cycle twice a year."

Overdue Accounts

Bills are due on the first of the month in advance, Thomas said, noting that most are paid by the 15th. "We consider an account delinquent if payment isn't received by the 15th."

Receivables are handled by Sally Lewis, Richmond Star Route's bookkeeper, corporate treasurer, and Thomas's sister. She enters appropriate payment data into the computer -- the account number, amount paid, the check number and the date payment was received.

On the 15th of the month, the computer automatically generates a postcard payment reminder for all past-due accounts. "The card shows the customer exactly what's paid and what's due," Thomas said, "along with a message: 'We have not received your payment for January. Please remit.'" The message can be changed at any time.

For accounts that show more than $20 overdue, the system generates an accounts inquiry statement -- an 8½ by 11-inch sheet showing the account number, name and address, telephone number and date service was begun. Thomas also wanted a complete payment history showing all checks, payment dates and amounts paid, as well as the months for which payment is past due. This was added to the system by a local programmer.

Richmond Star Route's policy is to follow up on late payment customers with a phone call. The credit clerk has their complete payment history while talking to them. So she generally knows more about the account than they do, which is an advantage. She can say: "I have your check number so-and-so for September dated such-and-such, and where is your check for October and November?" If she thinks they will pay, she simply sends them the inquiry statement as a record of their past payments. If they don't pay, they will show up delinquent the next month. Anybody $30 or more overdue is cut off from service. The matter then comes to Thomas's attention, and he personally contacts the customer.

Thomas emphasized that, "The inquiries by contact on the telephone and in person virtually eliminate any possibility of cutting someone off prematurely. We want to keep every customer we can, and we're as liberal as we can be with them."

Out of 760 customers, he recently had only 15 whose accounts were overdue, with a total of only $200 outstanding. "That's pretty good, and I credit the Contract Services System for the great improvement in my cash flow and receivables management," Thomas said.

The system also reconciles bank deposits, "Before we go to the bank with receipts, the computer prints out a list of all entries for the day and gives us a batch cash total for that day's transactions. We compare that figure with the total we arrive at by hand or adding machine on our deposit ticket, and if there's a discrepancy, we know we either added wrong or made an incorrect entry in the computer. If the computer total matches the deposit ticket total, we know everything's OK for that deposit."

New Subscribers

Thomas realized that if he could solicit new subscribers along his existing route, he could increase revenues without increasing costs for transportation. Thus, the additional business would be most profitable.

To find the names of potential customers for this route, a "filling-in" effort, he entered all residence names and addresses from the Richmond telephone directory (Richmond is a small community) into another system -- Mailing List Management. (Names and addresses of his existing customers were not entered.) The computer was then used to sort the list by street name. The names, addresses and phone numbers of potential customers on streets already serviced by Richmond Star Route were printed out by the system and contacted by representatives of the Kansas City Star. Also targeted were residents of new subdivisions.

As a result of the canvassing effort, Thomas increased his subscriber base by about 10 percent. In recognition of that accomplishment and the many other efficiencies which he introduced to the management of his route, Thomas was chosen from among 270 independent carriers as the Star Carrier of the Month.

How Did Mom Do It All?

Thomas has successfully used microcomputer technology and versatile software systems to modernize and streamline a business that generates a substantial amount of cash, but which leaves little room for mismanagement. "More than half my revenues go to the Star Company to pay for the daily and Sunday papers," Thomas notes. "Computerization with good software, particularly the Contract Services System, has enabled me to continue to succeed in a business that is fraught with pitfalls and details. In fact, there are a million details. That's why I still wonder how Mom managed to keep it all in her head." The main source of software has been International Micro Systems, Inc., 6445 Metcalf, Shawnee Mission, Kansas, 66202.

Ω

Computing and Data Processing Newsletter

COMPUTERS LOCATE 100,000 JOBS PER YEAR VIA MISSOURI STATE EMPLOYMENT SYSTEM

Don Kling
Div. of Community and Economic Development
State of Missouri
P.O. Box 118
Jefferson City, MO 65102

Computers have often been criticized for causing unemployment in industries where machines have taken over jobs once performed by people. But an ultra-modern computer system in Missouri, however, is assisting applicants seeking new jobs, as well as aiding Missouri businesses searching for new employees.

Bruce Cornett, director of the Missouri Division of Employment Security, believes the state's system is unique among the state employment divisions of the U.S.A. "The Missouri computer system spans three states and links every employment office within our network electronically. There isn't another state in the union that can say that," says Cornett.

The system located more than 200,000 jobs for workers from September 1983 through August 1985, an average of nearly 400 jobs per business day.

Businesses can define the types of workers they need, the number of people required, and the skills necessary to do the jobs. The Missouri system matches individuals against the criteria of the employer, and offers carefully screened applicants for the employer's consideration. With information on more than 25 percent of the total Missouri labor force compiled in the state's data base, employers have a large resource readily available for quick tapping.

Carl M. Koupal Jr., director of Missouri's Department of Economic Development, cites the state's computer operation of the Division of Employment Security as a fine tool in the state's economic development efforts. "The computer search offers invaluable assistance to inquiring businesses. It's a valuable service the state can provide to new businesses or businesses expanding in Missouri," says Koupal.

Chrysler Corporation wanted to hire 1,200 people for its plant in Fenton, Missouri. Missouri's Division of Employment Security handled some 13,000 applications for positions with Chrysler. After pre-screening for eligibility with criteria established by Chrysler, the Department of Economic Development referred about 2,000 suitable applicants. Twelve hundred of those applicants were subsequently hired by Chrysler.

Industries outside Missouri, which may be looking at the state for development of new facilities, can use the computer to research the potential workforce of any given area in the state. Industrial developers can turn to Missouri for a fast, accurate assessment of the number and type of qualified workers in any community or county.

The system links 60 field offices throughout Missouri, Kansas and Illinois to the main center in Jefferson City. More than 750 terminals electronically link each field office to the main center. The system is nearly paperless. This has reduced costs, improved productivity and minimized the problems associated with working with, sending and storing paper.

Records are entered, edited and stored electronically at the center in the state capitol. Any office can access information to help businesses find employers or individuals find jobs.

Contrary to taking jobs from people, the Missouri computer system "works extremely well for employers and employees alike," says Cornett.

COMPUTERS KEEP TASHKENT SUBWAY RUNNING SMOOTHLY

Vladimir Mizhiritsky
Novosti Press Agency
Moscow, U.S.S.R.

About the only thing drivers operating the trains of the subway in Tashkent, capital of Soviet Uzbekistan, have to do is open and close the doors in the stations. Computers take care of all the rest, keeping the 350,000 passengers a day happy.

The 25.5 km subway system of this city of two million in Soviet Central Asia is run almost entirely by computer. The two computer complexes in the subway operations center store all the train schedules compiled for each season of the year in their memory.

Just before 6 a.m. each morning, when the subway opens, the on-duty programmer feeds in the appropriate operating mode. Commands issued from the operations center travel along communication lines to station equipment boosted by logical units and relays, from where they are re-routed to the logical semi-conductor unified assemblies of each train. These activate the engines, and the trains start running.

When the subway is running normally, the operator will open the doors once the trains stop in the station, gauge the crowds, and close the doors once everybody is in. As soon as the doors close, the computer system issues the departure command, and the train moves to the next station automatically. If the train is behind schedule, the central computer will increase its speed; if ahead, it will decrease the speed.

Detailed information on each train's movement -- 20 pairs of trains run during rush hours -- is displayed on terminal screens in the operations center, where operators are able to keep tabs on how closely the trains are running according to schedule and on their locations along the route at any given moment. The system is duplicated to ensure reliability.

The centralized computer system is reinforced by two back-up systems. "If the operations center computers break down somewhere," says computer lab head Vladimir

A train pulls into the Lenin Square station of the Tashkent subway.

Lisetsky, "the station facilities assume control of the trains' movement -- their arrivals and departures. If communications between the trains and stations break down, or if station equipment also fails, operators can run the trains manually."

Computers not only run the Tashkent subway system, but help do repairs as well. If there is a break in the power cable, a high-voltage laboratory called Robatron helps spot the trouble. "Its equipment helps us pinpoint the faults in the cable," explains senior electrician Victor Pustalov. "The microcomputer then displays all the data received on a screen. That helps us find and repair any cable damage in the shortest time possible. It is a must for keeping the subway running smoothly without tie-ups."

AN UPDATE OF MACHINE TRANSLATION OF NATURAL LANGUAGES

Based on a report by Gail Griffin
"Unilever Magazine"
Unilever
Northampton, England
January, 1986

The annual market for translations from one natural language to another is estimated at 10 to 20 billion dollars, and in some areas is increasing at more than 15 percent a year. Japan and France are internationally oriented, and Canada has two official languages; these countries are particularly interested in machine translation (MT). In the European Community the cost of translations is estimated at about 500 million dollars a year. In the early 1970s a new generation of machine translation computers began, taking into account past errors, and using new ideas from artificial intelligence, computational and theoretical linguistics, and information retrieval to provide a linguistically accurate, theoretical base.

Until the late '60s MT was very basic. Text was translated word for word, paying little attention to analysis of grammatical structure or vocabulary. Researchers soon discovered that accurate translation could only be achieved by paying attention to the semantics, or meaning, of the text. Since then more sophisticated methods of MT have evolved on which all the commercial systems currently in use are based.

The first of these is the direct approach, which uses rules of grammar and syntax to translate from one language into another. The second, the "interlingual" approach, employs an internal intermediate language as a bridge between the "source" and "target" languages.

Following the invention of MT computers came the development of optical character recognition (OCR). This scans any text and converts it into mathematical form before putting it in the memory of the computer. OCR is rather restricted by its inability to read all typefaces but research is currently underway into producing a machine which can. This universal OCR will be a great boon in computer-assisted translation.

Current MT is confined to fairly simple, repetitive technical documents, such as catalogues and manuals, which have an unambiguous, limited but generally standard vocabulary. They also nearly always use the imperative, or past passive tense, which makes translation easier.

One of the main benefits of MT computers is their ability to read through documents and process them many times faster than a human translator can. Once installed, with the bugs ironed out of the system, costs begin to fall. The Canadian subsidiary of General Motors sells the services of its Systran machine both within and outside the company with rates up to one-third less than those of professional translators, whilst Xerox, who began using Systran eight years ago, handles 35,000 to 40,000 pages annually and has increased output and cut processing time.

The business possibilities of a fast and efficient service for those who do not require "literate" translations have resulted in translation bureaus springing up across Europe which take in work from all over the world.

However, not all texts can be translated by machine. The majority, with their reliance on implication and nuance, get mangled during the machine translation process.

The world's most ambitious MT research and development project currently underway is the $14 million Eurotra project set up by the European Community (EC). The principal aim of Eurotra is to combine European research in machine translation with a view to producing a system which will translate from any one Community language to another.

At Unilever, serious consideration has been given to the question of machine translation and how best it could benefit the company. "If Unilever dealt with nuts and bolts

and operated in just two or three countries," says Zoltan St-Gallay, head of Translations Department, Unilever House, "and if only simple, uniform and repetitive material needed translating on a large scale, then MT would be a feasible aid because it can give editable texts on material with little or no grammatical structure, such as parts lists and invoices.

"However, the bulk of our work is in a dozen languages and on some 50 subjects, ranging from fish filleting to surgical instruments, and a large proportion of it is complex not only in content but also in style, terminology and inference. No machine can yet cope with this variety and level of intricacy. Furthermore, the commercial systems available at present appear to be economically feasible only when the volume for a given language direction, such as German to English, exceeds one million words a year.

"Apart from the material that lends itself to machine-assisted translation, most competent translators feel that at present they can prepare better, quicker and more readable translations by themselves. If you are going to use a computer then you must first type in the original text, check the typed material on the screen for errors, spoon-feed the computer with all the terms it does not know, enter the same terms into its memory with the necessary grammatical codes, remove one or more of the alternatives the computer offers when it cannot make a choice, and finally edit the 'raw' machine translation for accuracy and style by comparing it with the original text. Even then, the result tends to be less accurate and more difficult for the end user to read and digest."

At the EC an accuracy rate of 65 to 70 per cent is generally acceptable as people there need to know the backgrounds to many subjects. In Unilever on the other hand, the accuracy rate needs to be 100 per cent and with MT as it stands this would require more work rather than less, as raw translations are still rather erratic. The EC's Systran system is, at best, capable of getting eight out of every ten words correct, but this fluctuates according to the complexity of the text and is usually rather less.

However, the future looks promising. A reliable and versatile optical character recognition machine at a reasonable price will obviate the need to type the foreign texts into the computer. Software packages will be cheaper and have much larger vocabularies of both general and specialized terms and expressions, including whole strings of words. Both these developments will make more texts amenable to machine translation.

Various commercial MT systems can then be tested on some language and subject combinations, such as German chemistry and French marketing, to assess them as regards the cost and quality of the raw translation, the ease and cost of editing it, and the acceptability of both the raw and the revised version to the end user. Certain texts, such as those on which management decisions are based, important correspondence, material for publication, legal documents and promotional literature are likely to defy machine translation for a long time to come.

Within the next five years the face of machine translation will have changed substantially. At the Cambridge Language Research Unit (CLRU), psychologists, programmers and translators are currently working on a computer which will break English down into "natural cognitive units of text." In layman's terms, this means programming the computer to understand and translate a text in its entirety, and not just word for word. As the analysis of the source text is all-important in machine translation this should make it easier to translate the same body of text into any language. The CLRU are also trying to obtain an analog computer, which should help clarify the grayer areas of language. If the funding holds out, the next five years should see some exciting steps forward in the development of machine translation.

At present the four major commercial MT systems available are Systran, Weidner, ALPS and Logos. The first three favor the direct approach whereas Logos uses the "interlingual" method. According to Bill Williams of the Cambridge Language Research Unit (CLRU) only Systran really qualifies for the term machine translation. The other three systems are considered machine-assisted systems, that is systems which rely on a human translator to correct errors, and it is with them that the commercial benefits lie in the foreseeable future.

Each of these systems can speed up the work of a translator substantially, but all need help from human operators to build up data banks which contain thousands of words, phrases, expressions and grammar, and to correct the many inaccuracies which result from the machine's imperfect understanding.

When Systran was adopted by the European Community in 1976, new language pairs were

developed: English to French 1976, French to English 1978, English to Italian 1979, English to German and French to German 1982, with work currently underway on French to Dutch and English to Dutch systems which should be operational by the end of 1986. In October 1985 work began on English to Spanish and English to Portuguese.

Weidner is the most commercially successful system in Europe and offers programs which translate English into French, Spanish, German, Portuguese and Arabic, as well as ones which translate French, Spanish and German into English. It uses software which includes a dictionary of a few thousand words and phrases, along with rules of syntax and grammar for each pair of languages involved. The main shortcoming of this system is that it only has an operating vocabulary of 9,000 words. However, though the system may throw back at you well over half the terms in the original text, their meanings can be typed into the computer's memory and "learnt."

ALPS is an interactive system which calls for continuous assistance by a human translator. Sentence by sentence translations are presented to the operator on screen, so that continuous changes can be made. These changes are also "learnt" by the computer and re-used when needed.

Logos uses a modification of the interlingual method for its German to English program. It incorporates a universal language which analyses structure and content, while using the direct method to complete the translation. The major drawback of the Logos system is its tendency to keep the German sentence structure when translating to English, which often makes nonsense of the text.

COMPUTER SYSTEM DEVELOPED TO TEACH READING, WRITING OF CHINESE CHARACTERS

Based on a report in "The Globe and Mail"
444 Front St. West
Toronto, Ont., Canada

A computer system that will teach people to read and write Chinese -- one of the most complex and intimidating languages in the world to learn -- is under development at the University of Alberta.

Gao Qingshi, a professor on leave from China's Institute of Computing Technology in Peking, and graduate student Liu Wen Feng are working on the project with computer science professor Wayne Davis.

They are devising the interactive, educational software, written in Pascal, for people who speak Chinese, but who cannot read or write the language. "A lot of children of overseas Chinese origin cannot read or write Chinese," Mr. Davis said.

Young Chinese Canadians may not have the chance to learn to read and write in their native language as they study at English or French school. In addition, many are discouraged by the complexity of the written characters, compared with English or Pinyin, the official conversion of Chinese to the Roman alphabet.

Chinese characters, unlike their English, French, German and Spanish counterparts, have a two-dimensional structure. A small number of basic characters -- these account for about 2 per cent of the 2,150 Chinese characters in common use -- are combined according to meaning, function and sound to construct more complicated, compound characters. These can then be expanded into a common vocabulary consisting of about 4,000 words.

Incorporated into the software are elements of "chunck theory" from the field of cognitive psychology. The theory, proposed in 1974 by Herbert Simon, a psychologist at Pittsburgh's Carnegie Mellon University, outlines how many groups of information the brain can store in its short-term memory.

By studying Chinese characters through the use of computer-generated pictures -- instead of dwelling on the strokes and structures -- fewer chunks of information are stored in this section, apparently increasing learning capacity. Students will thus not feel as depressed when studying, according to the group's research report, because the pictures will remind them of the new words they have learned.

The system also allows students to enlarge or reduce all strokes, pictures and characters, and move them vertically and horizontally on the screen. In addition, they can control the speed at which characters are written so the process can be seen more clearly.

The research is financed in part by a grant Mr. Davis obtained from the Natural Sciences and Engineering Research Council of Canada.

Ω

Withington – *Continued from page 9*

3. Companies don't change very fast either. IBM is indeed distributing its low-price products through retailers, but it was unable to change enough to run the retail outlets itself: IBM's retailers are all relatively small independents. IBM has also entered the communications business, as the article forecast, but slowly and with little success so far. And the broadcast and print media, despite many experiments, have yet to discover how to be effective participants in the information industries.

4. The dance is fast but the music doesn't change. Companies come and go: Osborne, Apple, Encore and Visicorp (among ·hers) have appeared since 1978 and come ·· cle. This explains why governme· panies can't compete: things sir too fast. But user software lo standards, and telecommunicati· are if anything more deeply er article confused tactical cha gy and markets with fundamen· structure.

But fundamental change · People will change (but wi computers), companies will cha·· will the music of standards and regu·· Generations must pass before the final outcome (if any) becomes clear, however, just as they have before when major cultural changes were assimilated. Given this longer time horizon, however, the concluding sentence of the 1978 article may still apply:

> "With uncertainty comes opportunity, as the information industries move into their most dynamic growth period ever." Ω

Games and Puzzles – *Continued from page 28*

MAXIMDIDGE

In this kind of puzzle, a maxim (common saying, proverb, some good advice, etc.) using 14 or fewer different letters is enciphered (using a simple substitution cipher) into the 10 decimal digits or equivalent signs, plus a few more signs. The spaces between words are kept. Puns or other simple tricks (like KS for X) may be used.

MAXIMDIDGE 8605

SOLUTIONS

NUMBLE 8603: Slowly run and do not die too soon.
MAXIMDIDGE 8603: A lie stands upon one leg; truth stands upon two legs.

Jones – *Continued from page 15*

be a machine capable of asexual reproduction -- a development whose impact almost defies comprehension.

A 1980 study, conducted jointly by NASA and the American Society for Engineering Education, maintained a single, 100 ton, self-replicating machine implanted upon the moon and directed simply to reproduce, its offspring doing likewise, would grow into an awesome manufacturing complex capable of rivaling the entire industrial production of earth in just 18 years! One can imagine this enormous off world system being channeled into assembling miles long solar power satellites, terraforming planets, and making every human ·ing materially rich. And almost for free. ·s as we know it might simply cease ·.

oday's Robots Are Still Clumsy and Stupid

· today we're stuck with robots that are clumsy, stupid, and a goldmine of pos-·lities. Foremost, however, is the chance · may evolve into the ultimate servants ·mankind, both at home, and in the lonely ·ths of space.

References

"Advanced Automation for Space Missions", NASA Conference Publication 2255, National Aeronautics and Space Administration, Washington, D.C. 20546

"Advances in Laboratory Automation Robotics 1984", Zymark Corporation, Zymark Center, Hopkinton, MA 01748

"Space Resources and Space Settlements", NASA SP-428, National Aeronautics and Space Administration, Washington, D.C. 20546

"The Case For Mars", Volume 57, Science and Technology Series, American Astronautical Society

"Mission to Mars", Oberg, James E.; Stackpole Books, P.O. Box 1831, Harrisburg, PA 17105

"The Knowledge Machine", Michie, Donald; William Morrow and Company, Inc., New York

"Reinventing Man: The Robot Becomes Reality", Aleksander, Igor; Holt, Rinehart amd Winston, New York

"If I Had A Robot", Winkless, Nelson B.; Dilithium Press, Beaverton, Oregon

Ω

Opportunities for Information Systems

— Instalment 3

THE COMPUTERIZED CONFIDANT

Edmund C. Berkeley, Editor

In these days there are probably more than 200 types or schools of human services such as psychologists, social workers, psychotherapists, family counselors, psychosomatic physicians, psychoanalysts, and the like, who provide explanation, comfort (empathy), and recommendations in regard to emotions, sorrow, fears, anger, depression, and so on, and therefore help people deal with their troubles in the real world. In an earlier era the usual functions of the professions of human services included praying, consulting oracles, listening to confessions, forgiving of sins, prophesying, blessing, baptizing, caring for the sick, and supporting orphanages, poorhouses, and homes for the aged.

At present a professional with approved degrees and certificates in one of the fields of human services often receives for his professional services $30 to $60 an hour, an ample annual income of $60,000 to $120,000 per year. If a tenth of one percent of the population of the United States are such professionals (say 250,000), then the market for this kind of service could be upwards of $2 billion a year.

The first and most famous "computerized confidant" was ELIZA, a demonstration program written by Dr. Joseph Weizenbaum of MIT, in 1966. This program imitated the kind of psychoanalysis where the practitioner follows the principles of Carl Rogers and never states his own views but simply asks the patient questions referring to his problems and his family.

More than 500 varying implementations of the ELIZA program now exist, some of them called by other names such as Doctor. The idea of course is fascinating: that you can get friendly (if not expert) help from a machine which can listen to all your secrets, reveal nothing to the outside world, and by means of a clever (but not magical, of course) program help you solve a lot of puzzlements and troubles which plague you, in much the same way as a wise and loving friend, companion, or relative. The machine will never be as clever and wise as an excellent psychosomatic physician. But your chances of finding such a physician who is affordable are not good. And if the machine is not always able to give you a good answer, it should be programmed to say, "I don't know, but here are some possible answers, and in such and such references you can find some more answers."

People would not like to be ordered or commanded by a "Computerized Confidant". But it is easy linguistically to convert orders or commands into requests or suggestions. The CC could say: "You might try . . . and see if that works." Or "What do you think about doing . . . for a change?" The program should have a response button marked "Oh!" You can hear a person change his mind when he says that kind of "Oh!" or the equivalent.

It should be easy to construct the interactive program of a Computerized Confidant:

1. Make a list of say 20 topics (with their synonyms) about which you would like to ask questions; for example, gloom (or depression), tiredness (or fatigue), lateness (or procrastination), . . .
2. Inventory the frameworks of ordinary questions which could be asked.
3. Arrange for the CC to offer to you for approval what it thinks is the meaning of your question.
4. If you say yes, then the CC gives you a reply.
5. If you say no, then the CC offers you another meaning.
6. Arrange for the CC to learn, as in game playing programs.

For more information about the plans (structure or architecture) for a CC, please write to: Opportunities Editor, *Computers and People*, 815 Washington St., Newtonville, MA 02160. Ω

Games and Puzzles for Nimble Minds and Computers

Neil Macdonald
Assistant Editor

NUMBLE

A "numble" is an arithmetical problem in which: digits have been replaced by capital letters; and there are two messages, one which can be read right away, and a second one in the digit cipher. The problem is to solve for the digits. Each capital letter in the arithmetical problem stands for just one digit 0 to 9. A digit may be represented by more than one letter. The second message, expressed in numerical digits, is to be translated using the same key, and possibly puns or other simple tricks.

NUMBLE 8605

```
                O L D
              * S A W S
              -------
                T L E U
T=H          O T T T
           R A O T
         T L E U
       -----------
       = T U D O W T U
```

22055 21622

(please turn to page 27)